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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE JIMTOWN QUADRANGLE, ROSEBUD AND BIG HORN COUNTIES, MONTANA

[Report includes 10 plates]

By

Colorado School of Mines Research Institute

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Conversion table

To convert	Multiply by	To obtain
feet	0.3048	meters (m)
miles	1.609	kilometers (km)
acres	0.40469	hectares (ha)
tons (short)	0.907	metric tons (t)
short tons/acre-ft	7.36	metric tons/hectare-meter (t/ha-m)
Btu/lb	2.326	kilojoules/kilogram (kJ/kg)

INTRODUCTION

Purpose

This text is for use in conjunction with the Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) maps of the Jimtown quadrangle, Rosebud and Big Horn Counties, Montana, (10 plates; U.S. Geological Survey Open-File Report 79-015). This set of maps was compiled to support the land planning work of the Bureau of Land Management in response to the Federal Coal Leasing Amendments Act of 1976, and to provide a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRAs) in the western United States. Coal beds considered in the resource inventory are only those beds 5 feet (1.5 m) or more thick and under less than 3,000 feet (914 m) of overburden.

Location

The Jimtown 7 1/2-minute quadrangle is in west-central Rosebud and eastern Big Horn Counties, Montana, about 36 miles (58 km) south of Forsyth, Montana, a town in the Yellowstone River valley about 44 miles (70 km) west-southwest of Miles City and 105 miles (168 km) east of Billings. U.S. Interstate Highway 94 and the main east-west routes of the Chicago, Milwaukee, St. Paul, and Pacific Railroad and the Burlington Northern Railroad follow the Yellowstone River and pass through Forsyth. The small town of Colstrip is 9.5 miles (15.2 km) north of the northeast corner of the quadrangle.

Accessibility

The Jimtown quadrangle is accessible from Forsyth, Montana, by traveling south on Montana State Highway 39, beginning at a point on U.S. Interstate Highway 94 about 8 miles (13 km) west of Forsyth, and going south a distance of about 46 miles (74 km) to the northeast corner of the quadrangle. State Highway 39 continues southwestward and southward across the quadrangle to the town of Lame Deer and the intersection with U.S. Highway 212, located on the south boundary of the quadrangle. A number of unimproved roads provide access to all parts of the quadrangle from State Highway 39, or from U.S. Highway 212.

The nearest railroad is a spur of the Burlington Northern Railroad which runs southward from the main line near Forsyth, a distance of about 35 miles (56 km) parallel with Montana State Highway 39, and terminates at the Peabody Coal Company's Big Sky coal mine, about 6 miles (10 km) north of the Jimtown quadrangle.

Physiography

The Jimtown quadrangle is within the Missouri Plateau division of the Great Plains physiographic province. The land surface is maturely dissected by Rosebud Creek and its tributaries. Rosebud Creek flows through the quadrangle from the southwest corner to the northeast corner and continues northeastward and northward to the Yellowstone River. Rosebud Creek has a flood plain ranging from 0.5 to 0.75 mile (0.8 to 1.2 km) in width. The principal tributaries have narrower flood plains. The hills bordering the flood plains rise steeply 200 to 400 feet (61 to 122 m) to plateaus capped by erosion-resistant reddish-colored clinker beds.

The highest elevation, 4,140 feet (1,262 m), is at the Lame Deer triangulation station in the southeast quarter of the quadrangle. The lowest elevation, about 3,040 feet (927 m), is on Rosebud Creek near the northeast corner of the quadrangle. Topographic relief is 1,100 feet (335 m).

Climate

The climate of Rosebud and Big Horn Counties is characterized by pronounced variations in seasonal precipitation and temperature. Annual precipitation in the region varies from less than 12 inches (30 cm) to 16 inches (41 cm). The heaviest precipitation is from April to August. The largest average monthly precipitation is during June. Temperatures in eastern Montana range from as low as -50°F (-46°C) to as high as 110°F (43°C). The highest temperatures occur in July and the lowest in January; the mean annual temperature is about 45°F (7°C) (Matson and Blumer, 1973, p. 6).

Land status

The north half of the Jimtown quadrangle is within the Northern Powder River Basin Known Recoverable Coal Resource Area (KRCRA), as shown by the Boundary and Coal Data Map (pl. 2). The south half of the quadrangle is within the Northern Cheyenne Indian Reservation which has been excluded from the KRCRA and in which the coal resources were not mapped. Plate 2 shows the land ownership status of the lands north of the Indian Reservation. There were no outstanding Federal coal leases or prospecting permits recorded as of 1977.

GENERAL GEOLOGY

Previous work

Dobbin (1930) mapped that part of the Jimtown quadrangle north of the Northern Cheyenne Indian Reservation as part of the Forsyth coal field, Rosebud, Treasure, and Big Horn Counties, Montana.

Stratigraphy

A generalized columnar section of the coal-bearing rocks is shown on the Boundary and Coal Data Sheet (pl. 3) of the CRO maps. The exposed bedrock units belong to the Tongue River Member, which is the uppermost member of the Fort Union Formation (Paleocene). This member consists of light-colored sandstone, sandy shale, and important coal beds. The thicker coal beds have burned along the outcrop and have fused the overlying rock into slag or clinker. The entire Tongue River Member is about 1,700 feet (518 m) thick in the Forsyth coal field (Dobbin, 1930, p. 16), but in the Jimtown quadrangle the upper part of the member has been removed by erosion and only about 1,100 feet (335 m) remains.

Coal and other rocks comprising the Tongue River Member were deposited in a continental environment at elevations of perhaps a few tens of feet (a few meters) above sea level in a vast area of shifting flood plains, sloughs, swamps, and lakes that occupied the Northern Great Plains in Paleocene (early Tertiary) time.

Representative samples of the sedimentary rocks overlying and interbedded with minable coal beds in the eastern and northern Powder River Basin have been analyzed for their trace element content by the U.S. Geological

Survey and the results summarized by the U.S. Department of Agriculture and others (1974) and by Swanson (in Mapel and others, 1977, pt. A, p. 42-44). The rocks contain no greater amounts of trace elements of environmental concern than do similar rock types found throughout other parts of the western United States.

Structure

The Jimtown quadrangle is in the northwestern part of the Powder River structural basin. The strata in general dip southeastward at an angle of less than 1 degree. In places the regional structure is modified by low-relief folds, as shown by the structure contour map on top of the Upper Rosebud and Lower Rosebud coal beds (pl. 5).

COAL GEOLOGY

Three coal beds are exposed at the surface in the Jimtown quadrangle. They belong to the Tongue River Member of the Fort Union Formation, and are shown in outcrop on the Coal Data Map (pl. 1) and in section on the Coal Data Sheet (pl. 3). The lowermost of the three is the Lower Rosebud coal bed which is about 350 feet (107 m) above the base of the Tongue River Member. The Lower Rosebud coal bed is overlain successively by a noncoal interval of about 110 to 150 feet (34 to 46 m), the Upper Rosebud (Lee) coal bed, a noncoal interval of about 210 feet (64 m), and the Sawyer coal bed.

The trace element content of coals in the Jimtown quadrangle has not been determined; however, coals in the Northern Great Plains, including those in the Fort Union Formation in Montana, have been found to contain, in general, appreciably lesser amounts of most elements of environmental

concern than coals in other areas of the United States (Hatch and Swanson, 1977, p. 147).

Lower Rosebud coal bed

The Rosebud coal bed was described by Dobbin (1930, p. 27) from outcrops along Rosebud Creek in the Forsyth coal field. A specific type locality was not given. North of the Jimtown quadrangle (in the Colstrip SW quadrangle), the Rosebud coal bed splits into two coal beds as it goes southward. Dobbin (1930) mapped the upper split as the Lee coal bed and the lower split as the Rosebud coal bed. Test holes drilled later for coal correlation confirm that the Lee coal bed is equivalent to the upper part of the Rosebud coal bed. Both splits crop out in the Jimtown quadrangle (pls. 1 and 3). The Lower Rosebud coal bed crops out along Rosebud Creek in the central part and in the northeast quarter of the quadrangle. The thickness of the Lower Rosebud ranges from 3+ to 14 feet (0.9+ to 4.3 m), as shown by the isopach map, plate 4. Structure contours on top of the Lower Rosebud coal bed (pl. 5) show an eastward or southeastward dip of less than 1 degree. Overburden on the Lower Rosebud coal bed (pl. 8) ranges from zero at the outcrop to about 600 feet (183 m).

There are no known published chemical analyses of the Lower Rosebud coal bed in the Jimtown quadrangle. The nearest chemical analysis of the Rosebud coal is from drill hole RB-69, sec. 5, T. 1 N., R. 40 E., about 8 miles (13 km) to the northwest in the Rough Draw quadrangle (Matson and Blumer, 1973, p. 79). This analysis shows ash 9.34 percent, sulfur 0.95 percent, and a heating value of 8,800 Btu per pound (20,469 kJ/kg) on

an as-received basis. This heating value converts to about 9,710 Btu per pound (22,585 kJ/kg) on a moist, mineral-matter-free basis, indicating that the coal is subbituminous B in rank. Since the Jimtown quadrangle has a similar position in the basin, it is assumed that the Rosebud coal in the Jimtown quadrangle is similar and is subbituminous B in rank.

Upper Rosebud (Lee) coal bed

The Upper Rosebud coal bed crops out near the base of the steep slopes both east and west of Rosebud Creek. The thickness of the coal bed ranges from about 6 to 11 feet (1.8 to 3.3 m), as shown by the isopach map, plate 4. Structure contours on top of the Upper Rosebud coal bed (pl. 5) show an eastward to southeastward dip of less than 1 degree. Overburden on the Upper Rosebud coal bed (pl. 6) ranges from zero at the outcrop to about 460 feet (140 m) in thickness.

A chemical analysis of the Upper Rosebud (Lee) coal bed from the McKay coal mine (sec. 34, T. 1 S., R. 41 E.), an abandoned, small mine in the northeast quarter of the Jimtown quadrangle, shows ash 7.1 percent, sulfur 0.6 percent, and a heating value of 9,160 Btu per pound (21,306 kJ/kg) on an as-received basis (Gilmour and Dahl, 1967, p. 18). This heating value converts to about 9,860 Btu per pound (22,934 kJ/kg) on a moist, mineral-matter-free basis, indicating that the coal is subbituminous B in rank.

Sawyer coal bed

The Sawyer coal bed was described by Dobbin (1930, p. 28) from exposures in the foothills of the Little Wolf Mountains in the Forsyth coal field (Rough Draw and Black Spring quadrangles).

In the Jimtown quadrangle, an extensive clinker bed formed by the burning of the Sawyer coal covers the tops of the hills on both sides of Rosebud Creek (pls. 1 and 3). There are no measurements of the Sawyer coal bed in the Jimtown quadrangle, but projections of thicknesses from the quadrangle adjacent to the east (the Badger Peak quadrangle) indicate that any Sawyer coal beds left unburned in the Jimtown quadrangle are less than 5 feet (1.5 m) in thickness. No maps of the Sawyer coal bed have been made.

Other coal beds

The Stocker Creek, Burley, and Robinson coal beds have been mapped in adjacent quadrangles, but there is insufficient data to support their mapping in the Jimtown quadrangle. The Stocker Creek coal bed occurs about 90 feet (27.4 m) below the Lower Rosebud coal bed in the Colstrip SW quadrangle just north of the Jimtown quadrangle. However, this coal bed is believed to thin southward and to be less than 5 feet (1.5 m) thick in the Jimtown quadrangle. The Burley coal bed occurs in the northern part of the Colstrip SE quadrangle just northeast of the Jimtown quadrangle, but it thins southward and is probably thin or absent in the Jimtown quadrangle. The Robinson coal bed was penetrated by an oil and gas test hole in the western part of the Black Spring quadrangle just west of the Jimtown quadrangle. Because there is a lack of additional data east of this well, an insufficient data line has been drawn in the eastern part of the Black Spring quadrangle.

COAL RESOURCES

Data from all publicly available drill holes and from surface mapping by others (see list of references) were used to construct outcrop, isopach, and structure contour maps of the coal beds in this quadrangle.

Coal resource tonnages shown in this report are the Reserve Base (RB) part of the Identified Resources, as discussed in U.S. Geological Survey Bulletin 1450-B.

The Reserve Base for subbituminous coal is coal that is 5 feet (1.5 m) or more thick, under 3,000 feet (914 m) or less of overburden, and located within 3 miles (4.8 km) of a point of coal-bed measurement. Reserve Base is further subdivided into reliability categories according to their nearness to a measurement of the coal bed. Measured coal is coal within 0.25 mile (0.4 km) of a measurement, Indicated coal extends 0.5 mile (0.8 km) beyond Measured coal to a distance of 0.75 mile (1.2 km) from the measurement point, and Inferred coal extends 2.25 miles (3.6 km) beyond Indicated coal to a distance of 3 miles (4.8 km) from the measurement point.

Reserves are the recoverable part of the Reserve Base coal. For surface-minable coal in this quadrangle, the coal reserves are considered to be 85 percent (the recovery factor for this area) of that part of the Reserve Base that is beneath 500 feet (152 m) or less of overburden, the stripping limit for multiple, thin (5 to 40 feet or 1.5 to 12 m thick) beds of subbituminous coal in this area.

Estimated resources in the Jimtown quadrangle were calculated using data obtained from the coal isopach map (pl. 4). The coal-bed acreage

(measured by planimeter) multiplied by the average isopached thickness of the coal bed times a conversion factor of 1,770 short tons of coal per acre-foot (13,028 metric tons/hectare-meter) for subbituminous coal yields the coal resources in short tons of coal for each isopached coal bed. Reserve Base and Reserve tonnage values for the Upper and Lower Rosebud coal beds are shown on plates 7 and 9, and are rounded to the nearest one-hundredth of a million short tons.

The total Reserve Base tonnage of federally owned, surface- and underground-minable coal in the Jimtown quadrangle is estimated to be 145.95 million short tons (132.38 million t). The Reserve Base tonnage totals per section are shown in the northwest corner of each section of CRO plate 2 and by development-potential category in tables 1 and 2. All numbers are rounded to the nearest one-hundredth of a million short tons. About 1.6 percent of the Reserve Base tonnage is classed as Measured, 16.1 percent as Indicated, and 82.3 percent as Inferred.

COAL DEVELOPMENT POTENTIAL

Areas where coal beds are 5 feet (1.5 m) or more thick and are overlain by 500 feet (152 m) or less of overburden are considered to have potential for surface mining and were assigned a high, moderate, or low development potential based on the mining ratio (cubic yards of overburden per ton of recoverable coal). The formula used to calculate mining-ratio values for subbituminous coal is as follows:

$$MR = \frac{t_o\ (0.911)}{t_c\ (rf)}$$

where MR = mining ratio
t_o = thickness of overburden
t_c = thickness of coal
rf = recovery factor = 0.85
0.911 = conversion factor (cu. yds/ton)

Areas of high, moderate, and low development potential for surface-mining methods are defined as areas underlain by coal beds having less than 500 feet (152 m) of overburden and having respective mining-ratio values of 0 to 10, 10 to 15, and greater than 15. Mining-ratio contours and the stripping-limit overburden isopach which serve as boundaries for these development-potential areas are shown on plates 6 and 8. The mining-ratio values for each development-potential category are based on economic and technological criteria and were provided by the U. S. Geological Survey. Estimated tonnages for Reserve Base coal in each development-potential category (high, moderate, and low), for surface mining are shown in table 1. Estimated tonnages are shown in a like manner for underground mining in table 2.

Development potential for surface-mining methods

The Coal Development Potential (CDP) map included in this series of maps pertains only to surface mining. It depicts the highest coal development-potential category which occurs within each smallest legal subdivision of land (normally about 40 acres or 16.2 ha). If such a 40-acre (16.2-ha) tract of land contains areas of high, moderate, and low development potential, the entire tract is assigned to the high development-potential category for CDP mapping purposes, etc.

In areas of moderate to high topographic relief, the area of moderate development potential for surface mining of a coal bed (area having 10 to 15 mining-ratio values) is often restricted to a narrow band between the high and low development-potential areas. In fact, due to the 40-acre (16.2-ha) minimum size of coal development-potential increments, the narrow strip of moderate development-potential area often is absorbed into the 40-acre (16.2-ha) tracts of high development-potential category. The Coal Development Potential (CDP) map then shows areas of low development potential abutting against areas of high development potential.

The coal development potential for surface-mining methods (less than 500 feet or 152 m of overburden) is shown on the CDP map (pl. 10). Most of the Federal coal lands in the quadrangle have a high development potential due to the superimposition of the Lower and Upper Rosebud coal beds. The Lower Rosebud coal bed has wide areas of high development potential above the outcrops on the sides of the valleys east and west of northeastward-flowing Rosebud Creek where the mining-ratio values are less than 10 (pl. 8). East and west of these areas, narrow bands of moderate development potential and larger areas of low development potential under thicker overburden are present above the Lower Rosebud coal bed. Only narrow bands of high development potential are located above the outcrops of the Upper Rosebud coal bed, which is relatively thin, farther east and west of Rosebud Creek (pl. 6). These bands are adjacent to the areas of high development potential for the Lower Rosebud coal, and extend the areas of high development potential up the sides of the tributary valleys.

Scattered, small tracts of moderate and low development potential are present where the coal beds are thin or are covered by thick overburden. An area of no development potential in the northeast quarter of the quadrangle is along Rosebud Creek where the coal beds have been removed by erosion. Approximately 72 percent of the Federal coal lands in the quadrangle has a high potential for surface mining, 4 percent has a moderate potential, 7 percent has a low potential, and 17 percent has no potential for surface mining.

Development potential for underground mining and in-situ gasification

The tonnage of identified (Reserve Base) coal resources for each bed lying below the stripping limit of 500 feet (152 m) but less than 3,000 feet (914 m) below the surface in this quadrangle is shown in table 2. On this basis the Lower Rosebud coal bed is estimated to contain 0.23 million short tons (0.21 million t) of underground-minable coal. However, coal is not currently being mined by underground methods in the Northern Powder River Basin because of poor economics. Therefore, the coal development potential for underground mining of these resources is rated as low, and a Coal Development Potential map for underground mining was not made.

In-situ gasification of coal on a commercial scale has not been done in the United States. Therefore, the development potential for in-situ gasification of coal found below the surface-mining limit in this area is rated as low.

Table 1.--Surface-minable coal resource tonnage by development-potential category for Federal coal lands (in short tons) in the Jimtown quadrangle, Rosebud and Big Horn Counties, Montana

[Development potentials are based on mining ratios (cubic yards of overburden/short ton of recoverable coal). To convert short tons to metric tons, multiply by 0.9072]

Coal bed	High development potential (0-10 mining ratio)	Moderate development potential (10-15 mining ratio)	Low development potential (>15 mining ratio)	Total
Reserve Base tonnage				
Upper Rosebud	14,850,000	13,960,000	31,770,000	60,580,000
Lower Rosebud	29,890,000	7,460,000	47,790,000	85,140,000
Total	44,740,000	21,420,000	79,560,000	145,720,000

Table 2. --Underground-minable coal resource tonnage by development-potential category for Federal coal lands (in short tons) in the Jimtown quadrangle, Rosebud and Big Horn Counties, Montana

[To convert short tons to metric tons, multiply by 0.9072]

Coal bed	High development potential	Moderate development potential	Low development potential	Total
Reserve Base tonnage				
Lower Rosebud	0	0	230,000	230,000
Total	0	0	230,000	230,000

REFERENCES

Dobbin, C. E., 1930, The Forsyth coal field, Rosebud, Treasure, and Big Horn Counties, Montana: U.S. Geological Survey Bulletin 812-A, p. 1-55.

Gilmour, E. H., and Dahl, G. G., Jr., 1967, Montana coal analyses: Montana Bureau of Mines and Geology, Special Publication 43, 21 p.

Hatch, J. R., and Swanson, V. E., 1977, Trace elements in Rocky Mountain coal, in Proceedings of the 1976 symposium, Geology of Rocky Mountain coal, 1977: Colorado Geological Survey, Resource Series 1, p. 143-163.

Mapel, W. J., Swanson, V. E., Connor, J. J., Osterwald, F. W., and others, 1977, Summary of the geology, mineral resources, environmental geochemistry, and engineering geologic characteristics of the northern Powder River coal region, Montana: U.S. Geological Survey Open-File Report 77-292.

Matson, R. E., and Blumer, J. W., 1973, Quality and reserves of strippable coal, selected deposits, southeastern Montana: Montana Bureau of Mines and Geology Bulletin 91, 135 p.

U.S. Bureau of Mines and U.S. Geological Survey, 1976, Coal resource classification system of the U.S. Bureau of Mines and U.S. Geological Survey: U.S. Geological Survey Bulletin 1450-B, 7 p.

U. S. Department of Agriculture, Interstate Commerce Commission, and U. S. Department of the Interior, 1974, Final environmental impact statement on proposed development of coal resources in the eastern Powder River coal basin of Wyoming: v. 3, p. 39-61.